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Screening of mustard mutants for resistance against mustard aphid, *Lipaphis erysimi* (Kalt.)

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Abstract
One hundred thirty eight mutants of mustard Pusa Bold variety were screened for their resistance to the mustard aphid, *Lipaphis erysimi* (Kalt.) under field condition during *Rabi* season 2016-17 at Research Farm of Agricultural Botany Section, College of Agriculture, Nagpur, Maharashtra, India. The screening was done based on the parameters of aphid infestation index and aphid population count. Results revealed that the aphid infestation indexranged from 0.78 (M_{63} Pusa Bold 1100 gy) to 4.43 (M_{351} Pusa Bold Control-2).Among all the observed mutants, 14 mutants were categorized as highly resistant (0.78 to 0.97 aphid infestation index), 22 mutants as resistant (1.15 to 1.95 aphid infestation index), 39 mutants as moderately resistant (2.19 to 2.87 aphid infestation index) and 63 mutants were categorized as susceptible (3.11 to 4.43 aphid infestation index). Highly resistant mutants may be used as doner parent in developing the cultivars resistant to mustard aphid.

Keywords: Aphid, *Lipaphis erysimi*, mustard, mutants, screening

Introduction
India is one of the largest rapeseed-mustard growing countries in the world and rapeseed–mustard is the second most important edible oilseed crop in India after groundnut in terms of area and production. In India, mustard is grown in 6.23 million hectares with a production of 9.34 million tonnes and productivity of 1499 kg per hectares Anonymous, (2019) [4]. Under the name of mustard are seven important oilseeds belonging to the Brassicaceae (Cruciferae) are grown in India. The *Brassica* attacked by various insect pests like aphid, white fly, painted bud, pea leaf, minor and saw fly but aphids are very serious pest in India Agrawal and Dutta, (1999) [1], Bakhetia and Sekhon (1989) [6] causing the yield loss in the range of 57.8–80.6% Bakhetia *et al.* (1984) [5], Singh and Sachan, (1994) [16]. On a heavy infestation, aphids are largely congregated underside of leaves, they curling and yellowing them and plants fail to develop pods, if young pods do not produce healthy seeds and also resulting plant to loss their growth Mamun *et al.* (2010) [11]. Pesticides have some limitation such as detrimental effect on natural enemies and also pollution of environment, due to this best alternative for the management of the pest should be considered as the use of tolerant varieties/mutants. Plants that are resistant to insect pests have the unique advantages of providing inherent insect control to the crop. Plant resistance, in most cases biochemical nature and a number of factors are responsible for resistance i.e. non-preference, antibiosis and tolerance to insects Kher and Rataul, (1991) [10]. Among the various control methods, varietal resistance has received priority in Integrated Pest Management Programme Hobner (1972) [8]. Therefore, the present experiment was planned to study the reaction of different mutants against mustard aphid.

Material and Methods
Current study was designed for screening of different mutants of mustard for their susceptibility against mustard aphid, *L. erysimi*. Experiment was done under field condition at Research Farm, Section of Agricultural Botany, College of Agriculture, Nagpur during the *rabi* 2016-17. One hundred thirty eight mutants were observed and replicated thrice in randomized block design. Seeds of Pusa Bold variety of mustard were irradiated by different concentrations of gamma rays i.e. 900Gy, 1000Gy, 1100Gy, 1200Gy and 1300Gy and also in combination with 0.5% Ethyl Methane Sulphonate (EMS). The experimental plot was deliberately sown late for aphid infestationandno plant protection measures were taken during the season. Each dose of the treatment had 30 gamma irradiated seeds and these seeds are sown in two rows replicated thrice. The details of treatments are mentioned in Table 1.

Table 1: Details of treatment

Treatments	Dose of mutagen
M_1 toM $_{30}$	Gamma irradiation with 900 Gy (Pusa Bold)
M_{31} toM $_{60}$	Gamma irradiation with 1000 Gy (Pusa Bold)
M_{61} toM $_{90}$	Gamma irradiation with 1100 Gy (Pusa Bold)
M_{91} toM $_{120}$	Gamma irradiation with 1200 Gy (Pusa Bold)
M_{121} toM $_{150}$	Gamma irradiation with 1300 Gy (Pusa Bold)
M_{151} toM $_{180}$	Untreated Control 1 (Pusa Bold)
M_{181} toM $_{210}$	0.5% EMS and 900Gy (Pusa Bold)
M_{211} toM $_{240}$	0.5% EMS and 1000Gy (Pusa Bold)
M_{241} toM $_{270}$	0.5% EMS and 1100Gy (Pusa Bold)
M_{271} toM $_{300}$	0.5% EMS and 1200Gy (Pusa Bold)
M_{301} toM $_{330}$	0.5% EMS and 1300Gy (Pusa Bold)
M_{331} toM $_{360}$	Water soaked Control 2 (Pusa Bold)

While recording the observations, five plants were selected randomly from each mutant. The observations on aphid population were recorded at weekly interval 30 days after sowing. Population was recorded by following 0-5 index method as per the methodology described by Patel *et al.* (1995) [14].

Table 2: Aphid index

Index	Description
0	Plant free from aphids.
1	Aphids present but colonies not built up. No injury due to pest appearance on plant.
2	Small colonies of aphids present on leaves of plant. Such leaves exhibit slight curling due to aphid feeding.
3	Large colonies of aphids present on leaves and others parts, damage symptoms visible due to aphid feeding.
4	Most of the leaves covered with aphid colonies and the plant shows more damage symptoms due to aphid feeding.
5	The plant completely covered with aphid colonies, plant growth hindered due to feeding (stunting).

The average aphid index was worked out by using following formula

$$\text{Average aphid index} = \frac{0N + 1N + 2N + 3N + 4N + 5N}{\text{Total number of plants observed}}$$

Where

0, 1, 2, 3, 4, and 5 are aphid indices

N = Number of plants showing respective aphid index.

Varieties are graded according to their aphid infestation index Muhammad *et al.* (2011) [13] as given below-

Table 3: Aphid infestation index and Designation

Aphid infestation index	Designation
Up to 1.0	Highly resistant
1.1 - 2.0	Resistant
2.1 - 3.0	Moderately resistant
Above 3	Susceptible

Results and Discussion

The aphid index data revealed (Table 4) that none of mutant found free from aphid incidence. Among all mutants of mustard, the mutant M_{63} (0.78), M_{69} (0.79), M_{77} (0.81), M_{74} (0.83) and M_{79} (0.87) were least susceptible and showed below 1.0 aphid index as highly resistant. Similarly, in the category of resistant mutant M_{70} (1.15), M_{75} (1.16), M_{90} (1.20), M_{68} (1.21) and M_{48} (1.22). The mutants M_{147} (2.19), M_{238} (2.21), M_{112} (2.25), M_{216} (2.26), and M_{38} (2.28) were found moderately resistant and mutant M_{348} found susceptible with (4.43) aphid index and it was at par with mutants M_{351}, M_{357}, M_{360} and M_{359} which recorded (3.42), (3.37), (3.32) and (3.22) aphid index respectively. The above findings are in accordance with Mishra and Singh (2019) [12] who screened 22 varieties/lines of Indian mustard and reported NDR08-14-1, NDR08-1, MCN14–33, MCN14–31, NDR1–11, MCN14–24, MCN14–23, MCN14–27 and NDR07-2 were resistant. Ankita *et al.* (2019) [3] observed re-confirm on the basis of aphid infestation index IC 491089, IC 312545, IC 385686 and IC 312553 were tolerant genotypes. Julia *et al.* (2018) [7] found that the mutagenic effectiveness was highest at 1000 Gy gamma ray treatment. Sarkate *et al.* (2015) [15] studied the reaction of 15 entries of the mustard against *L. erysimi*. He indicated that Jaikisan was most tolerant followed by RH-8813, Pusa bold, MAUL-2 and RH-8812. Ahmad *et al.* (2013) [2] reported that none of the genotype was free from aphids attack and the most tolerant genotype was Vangard with minimum (12.84) aphids per plant. Khedkar *et al.* (2011) [9] screened seventeen genotypes/varieties of mustard against aphid, *L. erysimi* for their susceptibility and reported that the varieties GM-2, GM-1 and GM-3 were highly resistant (HR). Mamun *et al.* (2010) [11] also reported similar findings that the lowest aphid infestation was observed on variety MM014-02wf. Thus, the earlier reports showed corroboration with present findings.

Table 4: Categorization of different mutants of Pusa Bold variety of mustard against *L. erysimi*

Category & symbol		Aphid Infestation Index (AII)	No. of mutants	Mutants
Highly Resistant	HR	Up to 1.00	14	M_{63}, M_{69}, M_{77}, M_{74}, M_{79}, M_{73}, M_{80}, M_{81}, M_{64}, M_{88}, M_{65}, M_{86}, M_{71}, M_{78}.
Resistant	R	1.10 to 2.00	22	M_{70}, M_{76}, M_{90}, M_{68}, M_{48}, M_{61}, M_{89}, M_{52}, M_{41}, M_{43}, M_{121}, M_{148}, M_{123}, M_{219}, M_{10}, M_{144}, M_{211}, M_{49}, M_{232}, M_{149}, M_{239}, M_{316}.
Moderately Resistant	MR	2.10 to 3.00	39	M_{147}, M_{238}, M_{112}, M_{216}, M_{38}, M_{322}, M_{141}, M_{317}, M_{323}, M_{187}, M_{208}, M_{217}, M_{235}, M_{230}, M_{186}, M_{36}, M_{199}, M_6, M_{182}, M_{138}, M_{237}, M_{301}, M_{308}, M_{210}, M_{306}, M_{185}, M_8, M_{200}, M_2, M_{91}, M_{108}, M_{300}, M_{209}, M_{109}, M_{294}, M_{201}, M_7, M_{272}, M_{181}
Susceptible	S	Above 3.00	63	M_{102}, M_{103}, M_{241}, M_{259}, M_{40}, M_{104}, M_{274}, M_{250}, M_{278}, M_{55}, M_5, M_{277}, M_{106}, M_{279},M_{244}, M_{154}, M_{18}, M_{174}, M_{253}, M_{295}, M_{11}, M_{268}, M_{298}, M_{299}, M_{16}, M_{171}, M_{173}, M_{271}, M_{31}, M_{44}, M_{105}, M_{155}, M_{162}, M_{169}, M_{178}, M_{180}, M_{177}, M_{156}, M_{158}, M_{242}, M_{95}, M_{59}, M_{172}, M_{176}, M_{151}, M_{270}, M_{152}, M_{350}, M_{349}, M_{333}, M_{358}, M_{335}, M_{336}, M_{355}, M_{334}, M_{331}, M_{352}, M_{353}, M_{359}, M_{360}, M_{357}, M_{351}, M_{348}.

Conclusion

Mustard aphid is the most destructive pest in *Brassica* which causes mojor yeild loses in India. The results of the present study demonstrated the presence of high resistance in Fourteen mutants having lowest aphid index (<1.00) against *L. erysimi*. These highly resistant mutants will be usedin further breeding programmes for development of aphid resistant/ tolerant varieties resulting in higher production of the mustard by reducing the use of hazardous chemical insecticides.

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